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Thesis

THE PRESENT STATUS OF CERTAIN AUDIO-VISUAL AIDS IN THE
BIOLOGY CLASSROOMS OF THE PUBLIC SENIOR HIGH SCHOOLS IN
THE STATE OF MASSACHUSETTS

Submitted by

David Zax

(B.S. Boston University, 1941)

In partial fulfillment of requirements
for the degree of Master of Education

1948

First Reader: Mr. Henry W. Syer, Assistant Professor of
Education
Second Reader: Dr. John G. Read, Associate Professor of
Education
Third Reader: Dr. G. Lawrence Rarick, Associate Professor
of Education

Gift of D. Zax
School of Education

June 25, 1948

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CHAPTER I

INTRODUCTION

A. Statement of the Problem

The objective of this thesis is to survey the present status of certain audio-visual aids in the biology classrooms of the public senior high schools in Massachusetts. To what extent are these classrooms equipped with these audio-visual aids and what use is being made of some of these aids? This is the question to be answered by this study.

It is the hope of the writer that the answer to this question will contribute to the improvement of the curriculum of biology in senior high schools.

B. Meaning of Audio-Visual Aid

Before an attempt is made to define the term "audio-visual," it would be well to discuss the development of the term. McKown and Roberts¹ state that the earlier used expression "visual education" has been largely replaced by the term "visual instruction," but even though this is widely used at the present time, it too has serious limitations. Nearly all forms of dramatizations, for instance, bring both a visual and an auditory experience, as does

¹Harry C. McKown and Alvin B. Roberts, Audio-Visual Aids to Instruction, p.6. New York: McGraw-Hill Book Co. 1942

also the sound film, description of an object, and explanation of a map. The sound film has broadened the original narrower conception of visual education.

Further, touch, taste, and smell can also be classified as channels for instructional aids. On this point Davis² says: "It is usually best to use many avenues of approach in learning. In some cases, it is desirable to experience the situation by simultaneous stimulation of many sense avenues." Touch in certain kinds of shopwork, taste in cooking, smell in chemistry are more important in these cases than visual or auditory experiences. Perhaps the term "multi-sensory" used to mean employment of all sensory experiences, as the Eighteenth Yearbook of the National Council of Teachers of Mathematics³ suggests might be more accurate than any of the other expressions used.

However, the average learner in biology uses touch, taste, and smell infrequently and hence these senses represent a relatively small part of the sensory experience in learning. An individual obtains in the biology classroom the greater part of his experience through his eyes, a

²Robert A. Davis, Psychology of Learning, p.357. New York: McGraw-Hill Book Co. 1935

³Multi-Sensory Aids in the Teaching of Mathematics, Eighteenth Yearbook of the National Council of Teachers of Mathematics, p.1, Bureau of Publications, Teachers College, Columbia University, New York 1945.

lesser part through his ears and even less through his other senses. Although the last are not to be ignored, on the basis of the number and applicability of experiences, the writer of this study feels that the term "audio-visual" is the most appropriate expression. For a biological approach to this study, "visual aids" is too limited in scope and "multi-sensory" is too inclusive, as explained above.

Perhaps from the above discussion a definition of audio-visual aid is apparent. Dent⁴ aptly defines this by saying: "Audio-visual is a term used to encompass visual aids, sound aids, and the various combinations of the two."

C. Value of Audio-Visual Aids

Many pupils learn words without comprehending their meaning. This is verbalism and is usually the result of insufficient experience with the subject at hand. It is the duty of the teacher to provide concrete teaching materials in the form of audio-visual aids as the basis of experience out of which understandings and insights may develop. Through an integration of concrete experiences generalizations develop. This is an important objective of teaching.

The importance of generalizations in teaching has been expressed by the committee on science of the National

⁴Ellsworth C. Dent, Audio-Visual Handbook, p.2. Chicago: The Society for Visual Education, 1939.

Society of the Study of Education in 1932 in its Thirty-first Yearbook.⁵ In it, it is stated that the major objective of education is life enrichment which may be accomplished by developing an understanding of principles or generalizations.

Allen⁶ expresses the importance and value of audio-visual aids very well when he states that people learn much faster with the use of audio-visual aids, that the learner retains much more information by this method, and that audio-visual aids captivate interest and stimulate mental activity.

D. Principles Developed as Guides to the Successful Use of Audio-Visual Aids

The following principles set forth underlie the successful use of audio-visual aids.

Audio-visual aids should be carefully selected. Just as care is necessary in selecting textbooks, so is it necessary in selecting the proper kinds of audio-visual aids. This selection may be done by any teacher experienced in the use of these aids. Administrators, on the

⁵A Program for Teaching Science, Thirty-First Yearbook of the National Society for the Study of Education, part 1, Bloomington, Illinois: Public School Publishing Co. 1932

⁶C. Howard Allen, Jr., "New Routes to the Mind", Voice of Reserve (March, 1947), p.14.

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basis of their training, are more or less competent to give counsel.

The teacher should know the specific use of each aid and how to use it effectively. Each aid has its own particular function and because of this it can be used more advantageously in one setting than in another. A knowledge, therefore, of the particular use of each aid is necessary in order to get the most out of it.

The aid should be appropriate to the age and experience levels of the pupils. An aid will fail in its purpose if it is not suitable to the abilities, needs, and interests of the pupils. If it is beyond the experience and the comprehension of the pupil, learning will be impeded; if it offers too inadequate a stimulus because of utter simplicity, it will cause unfavorable pupil attitudes.

Audio-visual aids should not be confused with entertainment. An audio-visual aid is not meant to be a device of diversion but a means of motivation.

The use of too many aids at one time will cause confusion instead of clarification. It is a known fact that one pertinent illustration is worth a dozen scattered or unrelated ones, which will tend to divert attention rather than focus it on the subject at hand.

Aids should be located conveniently and circulated efficiently. If the teacher does not have the aid when he needs it, or receives it when he does not need it,

adjustment in the lesson plan will have to be made and this usually results in confusion and a situation unfavorable to effective learning.

Finally, visual aids are supplements to learning and are not meant to be substitutes for the oral and written methods for gaining knowledge. They demand greater skill from the instructor who must devote time and energy in selecting the appropriate and most effective aid.

E. Classification of Audio-Visual Aids

Hoban, Hoban and Zisman⁷ have classified visual aids into five main groups: "The school journey; museum material, motion pictures, still pictures, and graphic material."

For purposes of this study, the present writer has further divided these groups as may be seen in the questionnaire in the appendix.

⁷Charles F. Hoban, Charles F. Hoban, Jr., Samuel B. Zisman, Visualizing the Curriculum, p.9, New York: The Gordon Company, 1937.

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CHAPTER II

CERTAIN AUDIO-VISUAL AIDS AVAILABLE TO THE BIOLOGY CLASS-
ROOMS AS REVEALED BY THE LITERATUREA. Previous Studies in the Field

Many articles have been written on what is being done on audio-visual aids in the classrooms of certain schools. There have been studies made, for example, on the use of the micro-projector and how valuable field trips are in teaching biology. A search of the literature revealed no study on the status of audio-visual aids in the biology classrooms of the public senior high schools in Massachusetts. The writer, therefore, felt the need for making an investigation of this problem, particularly because as a prospective teacher in biology he realized the necessity to collate and to present in systematized form for his own use and for others certain audio-visual presentations in the biology classroom and to offer possible suggestions for further studies that may be made.

The literature examined did reveal one study by Chapman⁸ which may be worthy of mention. This study investigated the status of visual aids in the secondary schools of Massachusetts. The author used the five group classification of visual aids as expressed by Hoban, Hoban,

⁸Leland Hildreth Chapman, The Present Status of Visual Aids in the Secondary Schools of Massachusetts. Unpublished Master's Thesis, Boston University, 1938.

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and Zisman⁹, namely, the school journey, museum material, motion pictures, still pictures, and graphic material. He incorporated the status of visual aids in biology with those aids of other sciences under the heading of "Science Studies." Inasmuch as this thesis is dealing with the status of certain audio-visual aids in the biology classrooms of the public senior high schools in Massachusetts, the writer feels that Chapman's study does not adequately approach complete coverage of his problem. However, it is interesting to note what Chapman says with respect to science:

The science department in the schools are large users of visual aids. Each aid is used to a large degree with the exception of exhibits from museum and stereographs. Almost three-fifths of the schools use silent motion pictures in this department. In regard to all of these aids the larger schools use appreciably more than the smaller schools.

In the pages that follow the writer will attempt to show certain audio-visual aids available for the teaching of biology as revealed by the literature.

B. Blackboard Equipment

Blackboards

Blackboards are an important aid in the teaching of science. They are very serviceable in the teaching of biology. Cellular structure of the blood tissues, principle

9. Opp. cit. p.9

of osmosis, process of digestion and assimilation, to mention a few, are biological concepts that can very well be presented on the blackboard and may be particularly elucidating when shown thus, step by step, even though there may be diagrams in the text. The blackboard, in this instance, is a good example of one visual aid supplementing another, namely text illustration.

The type of blackboard should be such that the board and crayon represent a sharp contrast in color. Movable blackboards are being increasingly used which enable all pupils to see the written material.

Colored Chalk

This aid is an indispensable part of the biology classroom. A picture in color has a greater appeal than one in white. All sketches, diagrams, and illustrations in biology may be particularly effectively shown by means of colored chalk. Different anatomical structures of plants and animals are well represented by this means. For example, the arteries and veins may be shown in red and blue respectively for a more ready and vivid presentation of the circulatory system in animals.

C. Still Pictorial Materials

Bulletin Boards

The bulletin board is handy for many subjects and especially biology. Every biology classroom should have a permanent bulletin board to display charts, posters,

diagrams, clippings and cutouts from newspapers and magazines. Members of the class should be encouraged to bring in and construct material for the bulletin board and in this way we can couple active participation with visual aid to encourage interest and receptivity.

In some classrooms the teacher has allowed the bulletin board to become overcrowded, unattractive, and filled with outdated material. Care should be taken to see that the material used is of immediate and direct applicability to the work at hand. The principles of display such as identifying with a title, labels, and notations stimulate the learning process of the pupils.

In connection with biology, all types of botanical and zoological pictures and diagrams may be displayed on the bulletin boards. Clipping from magazines supplied by commercial companies emphasizing good health habits may be used for a bulletin board display in connection with work in hygiene and sanitation.

Maps

Maps are visual aids which may be used in the biology classroom. They help the student to visualize and locate important world realities that he could never understand from written or oral material. For biology the map may be used to illustrate the habitat of plants and animals, and diseases endemic to an area of the world. Pupils may be asked to construct maps and the best ones may be tacked on

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Graphs

Graphs represent statistical data by means of a picture. They aid the learner by presenting this data clearly and interestingly. A good graph requires very little explanation because fundamentally it is simple.

The bar graph is the simplest type of graph. It is usually characterized by the use of parallel bars which represent a series of connected facts. Its use is extensive in the field of hygiene and sanitation. Percentages of diseases for a given area and time may be depicted by means of a bar graph.

The pie chart represents percentage or fractional values of a whole. Its visual aid lies in its simplicity and unity. It is best shown by shading in the pie cuts. One example of this use might be in the field of nutrition where a type of food may be shown giving its percentage of fats, carbohydrates, and proteins.

Area graphs may be used in the field of biology to show comparisons of amount differences. The amount of certain botanical and zoological material may be compared with the amount of the same type of material in another area. The most common figures for graphic representation of this kind are circles, rectangles, squares, and triangles.

The picture graph is used to show quantities by means of pictorial symbols. The picture used is a likeness of the

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things which it represents. The picture graph tends to animate statistics and to make statistical data concrete and interesting. The picture graph is of importance in the field of parasitology, for example, where a symbol of a parasite may be used to indicate the numbers of parasites and whether they have increased or decreased during a certain period.

Photography

There are two approaches in the use of photography and each shares in making the presentation effective and interesting. The student may use his own camera in photographing his observations. The apparatus used may be simple, a pin hole camera made by the pupil himself or an inexpensive commercial camera that will take as many as sixteen exposures on a roll of film that can be purchased for about twenty-seven cents. The biological student may use his camera for "before and after" experiments, for day to day growth and progress recording, for pictures of things seen on field trips. Photographs may be taken of botanical gardens, aboretums, zoological parks, and museums, for further reference and study. Further, now that color film has come into its own, this very important media is also available to the instructor for a certainly effective approach to a subject by means of audio-visual aid.

And, again, there are the photographs of others collected and accumulated from such sources as Nature, Science, National Geographic, and other magazines, travel agencies, museums, and newspapers, especially the "Christian Science Monitor." Whenever teacher and pupil cannot share direct contact with subject material, they may obtain much photographic material from the sources mentioned and also from commercial concerns which frequently publish photographic brochures on their processes. For example, many milk companies furnish profusely illustrated booklets of the Pasteurization process.

Diagrams and Posters

The diagram is a visual explanation of relationship and arrangement. It is the most abstract of visual aids and may be used to illustrate comparative values, origin and development, chronological sequences, as for example, a diagram of the circulatory or digestive system. Certain scientific laws such as Mendel's hereditary principles, may be illustrated by the diagram.

The poster is another important visual aid that is much used in biology. It is a means of vividly presenting in colorful and illustrated pictorial form ideas, facts, and principles that may be the more easily understood and assimilated than through a text or audio presentation. For example, graphic posters illustrating in full color the

foods that constitute the seven basic ones cannot but make a sharp impression on even the student who reads as he runs. Posters are very frequently used in the personal hygiene phase of biology, particularly depicting care of the skin, the teeth, and other Personal habits . Posters can be even more technical than the more familiar type mentioned above, like those showing the different chemicals of the blood and protoplasm. This done in many colors and in bold, clear cut type gets the message across frequently better than the text does. Or, the poster may be used in conjunction with text and lecture material, as is most often the case.

Cartoons

The cartoon is a visual aid emphasizing a fact by means of humor or satire. During the past few years excellent cartoons on insect control, health and conservation have been developed. The cartoon is effective in bringing out a point that is difficult to explain, or it helps to lighten a load that may be dull. Many laws and theories, Mendel's Laws of Heredity again, for example, can be epitomized with a cartoon.

Photos of Biologists

Photos of biologists placed about the classroom and brought to the attention of pupils will aid in bringing about an understanding of the development and growth of biology. They also serve to stimulate interest in learning

and understanding the achievements of biologists.

Wall Charts

According to Perry¹⁰:

Charts have at least three well-defined uses. First, they may supplement, even take the place of the text, and in this way be a direct means of giving new information. Second, they are valuable in staging review. Third, their construction frequently provides an excellent type of pupil activity.

Wall charts are extensively used in biology. Wall charts include the classification chart which shows sequence and interrelation of parts. The classification chart has one form which has special value in showing growth and development. This is the genealogical table, expressed in two ways: the tree form or the stream type form. Theories of evolution, for example, may be best illustrated by this form of chart.

The chart is most meaningful when it comes after the pupil has had an opportunity to obtain some concrete experience with the subject. After a field trip is made investigating plant and animal life, the wall chart may be used effectively when discussing these plants and animals.

¹⁰Winifred Perry, "Visual Aids for General Science Classes, Science Education 23 (Oct. 1939), p. 247.

The value of wall charts in teaching certain topics of biology was shown in a study made by Bergman¹¹ who found that when the material was presented with the help of charts, it was better retained than without the help of charts. The topics studied were: 1. external anatomy of the lobster; 2. internal anatomy of the lobster; 3. external and internal anatomy of the grasshopper and 4. internal anatomy of the frog.

Wall charts may be obtained commercially covering practically every phase of biology. Pupils should be encouraged to collect pictures and to mount them on a chart. Pictures on health, hygiene, insect, plant, and sea life may be collected and charts made from them.

D. Classroom Equipment

Filing Cabinets

Steel filing cabinets are valuable in preserving and storing pictorial materials such as diagrams, posters, charts, cartoons and graphs. Any projected program of audio-visual aids endeavoring to be comprehensive would fall short if adequate space were not provided; and filing cabinets are eminently satisfactory. Otherwise, many of the exhibits would be lost or damaged.

¹¹George J. Bergman, "Effectiveness of Charts in the Teaching of Certain Units in Biology," Science Education 24 (Feb. 1940) pp. 103-111.

The pictorial materials must be indexed for ready accessibility and this can well be done by the pupils who will acquire familiarity with the materials in doing so. Classification should be the teacher's job and she should decide the method of filing, that is whether by type of material (diagram, poster, charts) or under the different biological topics (circulation, respiration, hygiene and the like). If the former is used an effort should be made to classify the type of material according to biological topics within the type itself.

The cabinets must not be allowed to be filled with useless material. A check should be made at certain times for the purpose of removing obsolete and useless material.

Exhibit Cases and Shelves

Exhibit cases and shelves are used to display and to store models either obtained commercially or constructed by the pupils. Biological models such as the heart, ear, and the eye when placed in the laboratory will arouse student interest and thus may well stimulate the learning activity. Located in the corridor, they will give visitors and parents an idea of what is being done in the biology classes. The glass case is extensively used for displaying models. It gives protection to the materials being displayed.

Demonstration Desk for the Teacher

Effective teaching in biology requires the classroom to include a demonstration desk. By means of the demon-

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stration desk the teacher performs experiments to guide and stimulate the pupils in the use of the laboratory. When the teacher conducts the experiment and at the same time questions the pupils, an attempt is made to encourage the pupils in the subject.

An adequate demonstration desk should include a source of water, gas, and electricity. There should be drawers and cabinets for keeping materials and equipment. Placing the desk on a platform about six inches higher than the classroom floor is desirable for adequate visibility from every part of the classroom.

Models of the Human Anatomy

Probably the next best thing to the real thing is the model. It gives a correct representation of the object and enables the pupils to learn the interrelationship of the various parts.

Models of the human brain, heart, eye, ear, and torso may be obtained commercially or constructed by the pupils. They should be life-size, naturally colored, and dissectible showing the parts of the anatomy and their relationship. The study of digestion and respiration take on new interest and become fascinating subjects when a dissectible model of a human torso is available.

Bookcases with Biology Books for Use Other Than Regular Text

Pupils may do reading in biology courses on a required or voluntary basis. This reading may be divided into

collateral and supplementary.

A further understanding of a topic in biology may be gained by collateral reading. Some pupils may read to satisfy their desire for additional information. For this reason, the biology classroom should be equipped with different texts covering the work of the course.

Supplementary reading consists of recreational reading, reading on the history and the development of biology and any other readings not directly related to the topic being studied. This reading is desirable in that it can arouse an interest in biology in a number of pupils. Therefore, the biology classroom should include appropriate magazines, books, and pamphlets.

Human Skeleton

To comprehend the fundamentals of the human anatomy, the skeleton is an indispensable aid. By seeing the relationships of the various fundamental components of the human form, the pupil acquires a more vivid picture of the living human body.

E. Laboratory Equipment

Laboratory Manual

The laboratory manual serves as a guide to the students while doing laboratory work. It helps to focus attention on the important points of the laboratory work. Many of the newer manuals are supplying many of the specimen drawings in outline form so that the pupils need only to label

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them.

It has been the fault of many pupils and teachers to follow the laboratory manual as if it were a book of recipes. Probably no manual fits completely a local teaching situation, unless it is based upon a study of that situation, and even then it usually is not adapted well enough to the needs of the pupils to warrant following it religiously. The laboratory manual should be looked upon as a teaching aid which will facilitate the pupil's learning.

No discussion of manuals would be complete without some consideration given to the matter of the notebook. The notebook is used in order to hold the pupils responsible for laboratory work. It should include drawings and notes. Simple, properly labeled, outline drawings should be encouraged. Notes, not simply the usual notes describing drawings but clearly written accounts of observations, experiments, and conclusions are best.

Mounted Specimens

Mounted specimens serve to kindle interest and help to give an understanding of the biology work. They have a real use for the purpose of review. In this respect, the identification test is a common exercise. Mounted specimens may be numbered and the class asked to name them. One advantage of having mounted specimens is that they are permanent and so are relatively inexpensive.

Insect and bird collections, and dry and wet mounts of invertebrates are the commonest types of mounted specimens. Pupils may collect their own specimens and mount them in boxes.

Plastic Material and Wood for Modeling

Many of the models not available commercially may be made by biology students. The techniques involved are relatively simple and can be carried out by an average group of students. The common materials used in modeling are: plaster of Paris, modeling clay, papier mache, wood, and soap. In connection with these materials Mandl¹² says:

Plaster of Paris: A cheap material in model making. Should be mixed only when ready to use for it hardens quickly. Plaster of Paris may be poured into a tray which has been first covered with a fine film of oil. This prevents it from sticking. Plaster of Paris should be stirred into a small quantity of water until it reaches the consistency of thick cream. This may be used like modeling clay, that is, may be molded into place, or it may be poured into a mold for carving later.

Modeling clay: In making modeling clay projects it is desirable to place the model on a varnished board or some object which will not show the oil stain caused by the clay. Modeling clay has its advantages as well as its disadvantages. It is very pliable, and so changes may be easily made. However, it is very soft and requires great care in handling. When working with modeling clay various home tools may be constructed. An orange stick is desirable and bristles of a brush may be used as cilia. The entire model may be colored with an oil paint.

¹²M. M. Mandl, "Project Method in High School Biology," School Science and Mathematics, 31 (Dec. 1931) pp. 1089-1090.

As a result of the above, the Commission will not
recommend a change in the existing law and it is recommended
that the Commission should continue to work on the
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Papier mache: This is made from old newspapers which are torn up into small pieces, soaked in water with the addition of a small amount of glue. The paper is then kneaded into a pulp which turns it into a creamy consistency. The material is light when completed and does not break. The pulp is treated like modeling clay.

Wood: Those pupils skillful with tools may be encouraged to make models of wood. A coping saw can be used to make patterns of intricate design, which may be glued together to form almost any kind of model desired. With some wood filler, and the proper addition of modeling clay or putty, some exceptional work may be secured.

Soap: A fresh piece of soap is desirable. Dried soap will not carve easily and will chip and break. Ivory soap is about our best soap for modeling. A paring knife is our best tool. If larger models are desired, several pieces of soap may be glued. Models may be carved in relief, so they stand out, or may be carved into the soap as to be indented. The completed model may be painted and covered with a thin coat of shellac. Models should be attached to a board for handling.

Aquarium, Terrarium, Herbarium, and Conservatory

The above named are visual aids which stimulate and direct the learning process of students.

With the aquarium most of the fundamental principles of biology may be demonstrated. It shows the dependence of animals directly or indirectly upon green plants for their oxygen and food supplies. Respiration, digestion, growth, and reproduction of both plants and animals, parasitism, saprophytism, and food cycles are but few of the principles evident from an aquarium.

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One of the most useful aids about a biology classroom is the terrarium. The advantage of the terrarium is that humidity can be kept high so that many plants may grow successfully. The terrarium is useful for growing ferns, liverworts, and some mosses. It may be used for demonstrating typical plants of a swamp or desert area. It can also be used for caging small animals.

A collection of dried and preserved plants has an important role in any course in biology. When living specimens are not obtainable, dried or preserved forms are next in value as visual aids. The collection of such forms in a herbarium enables the teacher to exhibit groups of closely related species, genera, and families which are usually impossible to get together in a living state at the time they are needed.

The conservatory is a place where plants are grown and stored and as such affords the pupil an opportunity of observing the growing plant in its various stages. One advantage of the conservatory is that plants may be grown here in and out of season. A disadvantage of it is the cost which makes it prohibitive for the small school.

Dissecting Equipment

Various dissecting tools are needed as aids to learning in the biology classroom. These include dissecting needles, dissecting pan, scalpels, and a section razor.

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Collecting Equipment

Collecting equipment for small animals include hand nets, bottles with stoppers or jars with lids, with or without poison. Traps are best for capturing larger animals.

Cages for Animals

Small cages which may be constructed are a necessity about the biology laboratory where living animals are studied. One which answers the purpose for many insects and other smaller animals may be made from pound-size coffee cans. An ordinary fruit jar with a Kerr screw-cap can be made into a very satisfactory cage for many purposes.

Slides

An object to be studied under the microscope is mounted on a glass slide. Some slides are permanent while others are prepared for immediate use. The latter are known as wet mounts.

The making of prepared slides consists of a complicated process, and so are usually obtained commercially. All types of prepared slides may be purchased. Blood smears, tissue slides and bacteriological slides are but a few that may be obtained commercially.

Wet mounts can be made to observe such things as the living cell and the motility of bacteria. In both cases the living material must be kept moist by some fluid medium, hence, the term "wet mount."

January 1941

First meeting of the Committee on the 1st of January 1941.
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-The Committee on the 1st of January 1941.

February 1941

24th meeting of the Committee on the 24th of February 1941.
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March 1941

25th meeting of the Committee on the 25th of March 1941.
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26th meeting of the Committee on the 26th of March 1941.
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27th meeting of the Committee on the 27th of March 1941.
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Microscope, Magnifier and Lamp

The microscope is used for studying prepared slides or wet mounts. It is, of course, desirable to have one for each student but if this is not feasible students may "double up" or the micro-projector may be used. Instruction in the use of the microscope must be given to the students prior to use so that an intelligent handling is effected.

The hand lens or magnifier is valuable in the observation of insects and other small animals. In botany it may be used to observe the various parts of plants not easily seen with the naked eye.

In order for the pupil to utilize fully the benefits which a microscope offers, optimum light must be available. There are many forms of illumination. Daylight may be used but this is a poor source of light because of the lack of a point source of illumination. For this reason, special microscope lamps are advisable.

F. Classroom Facilities

Space for Laboratory Use

Cole¹³ expresses the following opinion in regard to the space for laboratory use:

In general we may say that any biology laboratory should provide a convenient supply of electricity, water, and gas; make provisions for an easy storing of equipment, including microscopes; supply

¹³William E. Cole, The Teaching of Biology, p. 106
New York: D. Appleton-Century Co. 1943

facilities where both live and preserved plants and animals may be kept for observation; provide for unrestrained individual pupil activity and for displaying pupil projects and collections; furnish opportunity for some plant and animal experimentation; arrange for free pupil discussion, and because of the present emphasis on demonstration work in all sciences, including biology--a demonstration desk for use by pupils and teacher.

Electrical Outlets, Gas, and Water

Not much need be said with respect to electrical outlets than to say that biology classrooms should have adequate provision for the use of projection equipment. Outlets are necessary not only for the use of projectors but for the use of other equipment such as microscope lamps.

Gas and water are a necessary part of the biology classroom. Without them few, if any, experiments could be carried on. Water, also, serves its use as food for animals.

Motion Picture Screens, Stationary and Portable

Successful projection of pictures requires a suitable reflecting surface such as a screen. There are two types of screens: the stationary and the portable.

Since films are of most value to the pupils when shown in the classrooms, permanent screens would entail the expense of having them in every classroom in which films are shown. On the other hand, portable screens require more time to transport and set up.

In either type of screen two factors should be considered: the direct reflective power of the screen and the

January 10, 1911. The following
information was obtained from the
United States Department of the Interior
Bureau of Land Management, Washington, D. C.
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largest angle to which the screen will reflect pictures satisfactorily.

Sink

At least one sink is necessary in each biology classroom. The purposes of the sink is to rinse instruments and to dispose of wates from dissections and experiments.

General Storage Room

The presence of a general storage room for the biology department prevents the accumulation of materials infrequently used but nevertheless of importance. The storage room is also the place to keep excess materials.

Flat-Top Desks for Student Laboratory Use

It is desirable that the tops of laboratory desks should be alkali and solvent resistant. In biology, desks which accommodate two or four students are preferred to those accommodating more students. It is also desirable that desks be provided with locker and drawer space.

G. Projection Equipment

Micro-Projector

The micro-projector is one of the recent advances in the projection of visual-aid apparatus for the teaching of biology. It is an apparatus for showing microscopic specimens on the screen. Some such specimens include bacteria, protozoa, and algae. An advantage of the micro-projector is that it enables the teacher to point out the various things he wants the class to see. This is an impossibility in the

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CHICAGO, ILL.

1911

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ordinary microscope study. Another advantage is that the micro-projector may well take the place of several expensive microscopes in the ordinary biology classroom.

In a study by Brechill¹⁴ neither the individual microscope nor the micro-projector showed marked superiority as a teaching instrument in groups of any particular intelligence level. When the pupils were questioned as to which instrument they preferred, some said the microscope while a larger number favored the micro-projector. The author concluded:

Best teaching might be done if a method were adopted which combined the use of the two instruments. Some skill in the manipulation of a microscope and appreciation of its use seems to be unquestionable assets for students.

An acquaintance with the general appearance of a slide, gained by observation of the image thrown upon a screen by the micro-projector, would place a student in a better position to recognize and understand the material later, when he was given an opportunity to study it under a microscope.

Stereoscope and Stereograph

The stereoscope is an optical instrument used to make surfaces appear as solids and to give an impression of depth.

There are two kinds of stereoscopes used in the school today. These are the small stereoscope which pupils can

¹⁴Edith Brechill, "A Study of the Micro-Projector as a Teaching Aid," Science Education 26 (April 1941) pp. 215-218.

hold in their hand to see the stereograph; and the telebinocular, a much larger and heavier instrument which is generally placed on a table for use and is electrically equipped.

The stereoscope has its uses in many studies. Because it produces the impression of the third dimension, it is used in physics, particularly in the field of mechanics; in mathematics, particularly in geometry; and in biology for microscopic examination of such objects as bacteria and protozoa.

The stereograph consists of two photographs of an object taken simultaneously by a stereoscopic camera, one which has two lenses, and when mounted and viewed through a stereoscope, binocular vision results.

The importance of the stereograph as a visual aid is¹⁵ expressed by Dorris :

Of all the static pictures available for school use, the stereograph is unquestionably the most valuable as a means of conveying vivid experiences and accurate mental concepts to the minds of young children. With the exception of the flat picture, it is the most valuable and the most convenient to use in the natural teaching situation.

Lantern Slides

When projected on a suitable screen, lantern slides

¹⁵Anna V. Dorris, "Visual Instruction in the Public School", p. 135 Boston: Ginn and Co. 1928.

give a clear picture in which details are brought out distinctly. Excellent slides illustrating all phases of biology may be obtained commercially or made by teachers and pupils.

Teachers should become familiar with outfits furnished commercially to make lantern slides. Blank slides of ground glass, colored pencils, cellophane sheets, and bottles of various shades of transparent ink are included in these outfits. The ground glass slides on which diagrams and pictures are drawn may be cleaned and used repeatedly. Transparent inks or water colors may be used for coloring slides. These, too, may be washed off and the slides used again.

A statement of the value of lantern slides is found in "Visual Aids for General Science Classes":¹⁶

Slides may be used for class discussion. Unlike the stereograph they are suited to group activity. They have an advantage over film strip and still film in that they may be shown in any desired order, and all slides in a set need not be shown unless they are needed. They are also valuable in opening new vistas and in arousing interest in a new unit or subject. Slides also provide excellent material for review.

Stereopticon or Lantern Slide Projector

In order to obtain a clear projected picture of the lantern slide, it is necessary to have a good lantern slide projector, one which meets a set of standards. Some of these

¹⁶Op. cit. p. 247

standards as expressed by Hoban, Hoban, and Zisman¹⁷ are:

1. It should be simple in construction.
2. It should be light but durable.
3. It should contain, above everything else, good lenses and reflector.
4. It should have a convenient slide carrier.
5. It should be easy to set up, to adjust, to operate, and to clean.

Opaque Projector

The opaque projector is used to show non-transparent material such as photographs, postcards, book illustrations, and drawings. These materials are reflected as images on a screen by means of mirrors in the projector.

The picture is usually inserted at the bottom of the projector and a spring is provided to hold the picture in place. It is so constructed that an entire book may also be inserted.

A valuable asset of the opaque projector is that the material used costs very little or nothing. Color can be shown naturally and realistically so that it is of value in the projection of such specimens as leaves and flowers whether they be mounted or appear as a colored picture.

Motion Picture Projector

Motion picture projectors are important. They are relatively expensive pieces of projection equipment and entail the added expense of having portable or permanent screens, and films. Besides their expense, portability is

¹⁷Op. cit. pp. 166-167.

The following are the names of the persons who
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 of the Board of Directors of the
 American Red Cross Society, for the
 year 1917-1918.

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The following are the names of the persons who
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another factor which limits the use of this equipment in the classroom. Newer models, however, are made lighter than earlier ones with the result that they can be carried from one classroom to another.

Film Strips

The film strip is a roll of still pictures printed on motion picture film which may be projected on a screen. The film strip has several advantages over the glass lantern slide in that it is inexpensive, less bulky, and non-breakable. The film strip does not, however, give a good picture with distant shots or those requiring great detail.

Film strips may be obtained commercially covering all fields of science. Excellent film strips in biology covering health, physiology, and plant and animal life may be obtained in this way.

Sound and Silent Motion Pictures

There are several reasons why the motion picture is one of the best types of projected visual aid. With the motion picture camera, one can take pictures of any rapidly moving object, the speed of which makes it impossible to be studied by the unaided eye. The same device may be used to speed up action to a point where an object can be studied in but a few minutes, such as the life cycle of a plant. Similarly, it can be used to stop the action of a moving object at any time to allow the class to study it.

As well as its advantages the motion picture also has its limitations. It is a substitute for the actual experience. The school journey should be used to study life in its natural environment if it is possible. The motion picture should only be used in those situations where motion is necessary to give the right impression. A motion picture of an inanimate object is not as good as a good projected still picture, photograph, or model of an object.

H. Activities

Biology Club

The school club is becoming an increasingly important part of the educational curriculum. Such an activity was formerly spoken of as extra-curricular but today it is looked upon as an extra-class activity.

In large high schools, separate science clubs for each of the sciences may be advisable but in small high schools, a single science club made up of students from all the sciences is best.

The success of the science or biology club depends upon its organization and execution of its programs. All pupils enrolled in science courses should be encouraged to join and the club should have a faculty advisor, preferably one of the science teachers. It is important that the program be so diversified that an interest is developed within the student for the science. The program of the club may include experiments, displays of projects, field trips,

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reports on science topics, lectures by men of science, social gatherings, and the like. The faculty advisor should allow the students to execute the programs.

By means of a biology club organized at the Julia Richman High School, New York, New York, the faculty advisor¹⁸ was able to discover and encourage individual interests and aptitudes with gratifying results. She concluded:

The biology club proved valuable for its vocational, avocational, and cultural contributions. It also encouraged the development of scientific attitudes and habits of thinking. Since these are the fundamental objectives of secondary education, I believe that the organization of a biology club is an effective device for individualized instruction and an aid in the preparation of our youth for efficient living.

Field Work and Trips

One of the most effective visual aids for the biology teacher is the field trip because it deals with real things in real situations. If pupils are studying water purification they may visit a nearby plant to observe the procedures used. In this way, the study of water purification does not become a long and difficult one but a concrete experience in which it becomes relatively simple.

Material collected on a field trip in biology may be used for further study. The better specimens collected may

¹⁸Frieda Fichtman, "The Biology Club for Individualized Instruction," School Science and Mathematics 36 (Dec. 1936) p. 973.

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be preserved and kept as a part of the permanent laboratory collection. No expensive equipment is necessary for any field trip. For the pupils to be taken on a tour of the world outside under the guidance of their biology teacher will make them aware of things as they are and will bring to life their text book and many interests that lay dormant.

A study by Stevenson¹⁹ of pupil comments showed that when field trips were successfully conducted they were the most valuable, enjoyable, and worthwhile portions of the class work. The field work also brought the students in contact with more actual science and contributed most to teacher preparation. An article by Washton²⁰ mentions that 93 per cent of nearly twelve hundred students questioned felt that their study of biology would have been more interesting if outdoor classes had been held. Schellhammer²¹ demonstrated by means of an experiment that field trips enlarge the pupils learning process to a measurable degree.

Planning and Working on Exhibits

The planning of an exhibit will prove entertaining and educational to the pupils. Teachers know that pupils are more

¹⁹E. N. Stevenson, "Questionnaire Results on the Value and Extent of the Field Trip in General Biology," Science Education 24 (Sept. 1940) pp. 380-382.

²⁰N. S. Washton, "Findings in the Teaching of Biology," School Science and Mathematics 41 (Apr. 1941) pp. 553-558.

²¹F. M. Schellhammer, "The Field Trip in Biology," School Science and Mathematics, 35 (March 1935) pp. 170-173.

interested in the concrete than in the abstract and that the oral or written word means very little unless there is some previous concrete experience with the object symbolized by the word.

The many and varied exhibits make possible the bringing together of the energies of pupils possessing different abilities and interests. Pupils may construct models which with posters explaining the model serve as fine exhibit material. Others may collect botanical and zoological specimens which may be dried, preserved, and mounted in boxes. These specimens can be made a part of a permanent collection.

The site of the exhibit will have to be chosen and equipment such as shelves, glass cases, and tables will have to be assembled and arranged. Each article in the exhibit should be so labelled that it is easily identified.

Dramatizations

Dramatization of biological principles and historical events are a neglected form of visual aid. The success of such motion pictures as "The Life of Louis Pasteur," "Madame Curie," and "Dr. Ehrlich's Magic Bullet" furnish good evidences that stories of scientific nature furnish acceptable themes for entertainment. Short plays based on the life of Florence Nightingale and Robert Koch have been successfully staged by high school pupils.

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In making plans for using a dramatization, proper selection of a cast is necessary. Only the best students should be selected. It is advisable to have an alternate for each part in the play.

An example of a dramatization presented at Palmyra High School, Palmyra, New Jersey during an assembly period of the school year 1936-1937 is given by Heiss, Obourn and Hoffman:²²

The advancement of medical science through the ages:

- Part I. Primitive Practices in Medicine Sketch:
The Medicine Doctor as shown by the Indians
- Part II. The Transitional Period
Tableau: Dining Scene in Ancient Castle
Showing Unsanitary Conditions of the Time
- Part III. A New World is Discovered Play:
Scenes from the Life of Pasteur
- Part IV. Modern Medicine
Tableau: The Nurse (Florence Nightingale)
and Doctor at Work

The program took forty-five minutes. Each teacher in the science department supervised one of the four parts, giving both direction and equipment to the students. The costumes were made by the students.

Biological Scrapbook

This scrapbook is composed of clippings of biological interest, pictures and news items taken from magazines and newspapers. It seems advisable that the scrapbook be one of

²²Elwood D. Heiss, Ellsworth S. Obourn, and C. Wesley Hoffman, Modern Methods and Materials for Teaching Science, pp. 222-223, New York: Macmillan Co. 1940

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the optional activities of the biology students and that it be restricted to the acquisition of current material only.

The present volume is the first of a series of
volumes on the history of the United States.

1890.

CHAPTER III

CERTAIN AUDIO-VISUAL AIDS USED IN THE BIOLOGY CLASSROOMS OF
THE PUBLIC SENIOR HIGH SCHOOLS OF MASSACHUSETTSA. Method of Procedure and Sources of DataDistribution of Check Lists

The questionnaire in the Appendix was mailed to every public senior high school in the State of Massachusetts. They were addressed to the heads of the biology departments. The number of questionnaires totaled 258. Of the 258 mailed, 143 or 55.4 per cent have been returned to date. In compiling the results all 143 returns have been used.

Geographical Distribution of Returns

The outline map on the following page shows the geographical distribution of the schools cooperating in this study. Although the schools were not asked to disclose their names on the questionnaire, an inspection of the post mark seems to be good evidence of their location. It may be seen that an overall distribution seems to be fairly representative in spite of a large clustering of dots about such large cities as Boston, Worcester, and Springfield. The cluster of dots about Boston represent many schools in the suburbs of Boston. There were 7 returns from the public senior high schools of Boston proper and these are shown by a single dot to the right of the cluster.

Validity of the Present Study

In discussing the validity of this study, we are con-

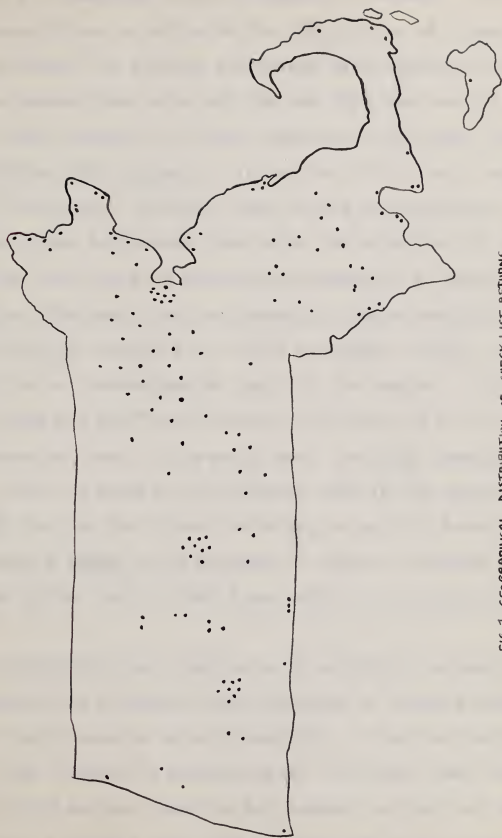


FIG. 1. GEOGRAPHICAL DISTRIBUTION OF CHECK LIST RETURNS



cerned if it measures what it attempts to measure. The questionnaire was constructed for the purpose of determining to what degree the biology classrooms were equipped with certain audio-visual aids and the use that was made of these aids. This covers, it is felt, the use of the term "status."

In the first chapter, a definition of the term "audio-visual" was given. All the items in the questionnaire conform to the definition given with the exception of such classroom facilities as electrical outlets, gas, water, space for laboratory use, and general storage room; and such classroom equipment as filing cabinets, exhibit cases or shelves and demonstration desk for the teacher. Although these items are not "audio-visual" in nature, they do affect the status and use of aids which are. For this reason the writer felt the desire for including them in the survey. Although many of the items listed may be used in departments other than biology, nevertheless, it cannot be denied that the aids listed can and have been used in the biology classrooms.

In concluding the discussion of validity, one may raise the question as to whether the sum total of schools answering the questionnaire is representative of all the public senior high schools in Massachusetts. The fact that the figures reported are based on 143 schools or 55.4 per cent and that the returns came from all sections of the state indicate an adequate sampling or a representative return.

The first of these is the fact that the
 government is not a single entity, but a collection
 of many different departments, each with its own
 interests and objectives. This makes it difficult
 to coordinate policy and action across the
 various departments. The second is the fact that
 the government is not a single entity, but a collection
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 of many different departments, each with its own
 interests and objectives. This makes it difficult
 to coordinate policy and action across the
 various departments.

Preparation of Tables and Graphs

In giving the results of this study in tabular and graphic form, percentages are given to the nearest tenth of a per cent. Audio-visual aids which fall into the same general classification will be treated as a group.

B. Blackboard Equipment

Table I Present status of blackboard equipment and degree to which it is used in the biology classrooms.

	On Hand	Used Often	Used Seldom	Never Used
Blackboards.....	98.6	97.9	2.1	0
Colored chalk.....	80.5	63.5	34.8	1.7

Findings Table I

As may be seen from Table I, the biology classrooms are well equipped with blackboards and colored chalk and that they make extensive use of these aids.

C. Still Pictorial Materials

Heads of biology departments were requested to report on the status of these aids by indicating whether the aids were on hand, and the degree to which the aids were used. Table II is a summary of the results.

Table II Present status of still pictorial materials and degree to which they are used in the biology classrooms.

	On Hand	Used Often	Used Seldom	Used Never
Bulletin boards.....	87.6	78.4	20.0	1.6
Maps.....	50.4	20.9	65.2	13.9
Graphs.....	43.4	16.1	67.8	16.1
Photographs.....	77.6	69.1	29.1	1.8
Diagrams and Posters.....	83.9	80.0	20.0	0
Cartoons.....	30.8	6.8	88.1	11.4
Photos of Biologists.....	45.5	17.0	79.9	3.1
Wall charts.....	78.3	89.0	11.0	0

Findings Table II

The results tabulated in Table II show that bulletin boards, diagrams and posters, and wall charts are the most available aids in that order among the still pictorial materials. Cartoons are the least available of this group in the biology classrooms.

Wall charts are the most used of these aids, with almost 90 per cent of the schools reporting making frequent use of them. Diagrams and posters, and bulletin boards came next as being used often.

ANNUAL REPORT OF THE
COMMISSIONER OF THE LAND OFFICE
FOR THE YEAR 1887

Year	Area	Value	Notes
1881	1,475	1,475	.....
1882	1,475	1,475	.....
1883	1,475	1,475	.....
1884	1,475	1,475	.....
1885	1,475	1,475	.....
1886	1,475	1,475	.....
1887	1,475	1,475	.....
1888	1,475	1,475	.....
1889	1,475	1,475	.....
1890	1,475	1,475	.....
1891	1,475	1,475	.....
1892	1,475	1,475	.....
1893	1,475	1,475	.....
1894	1,475	1,475	.....
1895	1,475	1,475	.....
1896	1,475	1,475	.....
1897	1,475	1,475	.....
1898	1,475	1,475	.....
1899	1,475	1,475	.....
1900	1,475	1,475	.....

Table 1.
Area and Value of Land.

The following table shows the amount of land owned by the State of New York, and the value of the same, for each year from 1881 to 1899. The land is classified into three classes, viz: land owned by the State, land owned by the people, and land owned by the United States. The value of the land is given in dollars and cents.

The following table shows the amount of land owned by the State of New York, and the value of the same, for each year from 1881 to 1899. The land is classified into three classes, viz: land owned by the State, land owned by the people, and land owned by the United States. The value of the land is given in dollars and cents.

D. Classroom Equipment

Table III Present status of biology classroom equipment and degree to which it is used.

	On Hand	Used Often	Used Seldom	Used Never
Filing cabinets.....	53.1	64.5	28.9	6.6
Exhibit cases or shelves.....	62.9	64.5	34.4	1.1
Demonstration desk for the teacher.....	90.1	83.9	16.1	0
Bookcases with biology books for use other than regular text.....	68.5	64.3	35.7	0

Findings Table III

This table shows that among the classroom equipment the most available aid is the demonstration desk for the teacher. It is also the most often used of all these aids with over four-fifths of the schools reporting using it often.

STATE OF NEW YORK

IN SENATE,
January 12, 1909.

REPORT OF THE	COMMISSIONER OF	THE	LAND OFFICE
1908	1909	1910	1911
1912	1913	1914	1915
1916	1917	1918	1919
1920	1921	1922	1923
1924	1925	1926	1927
1928	1929	1930	1931
1932	1933	1934	1935
1936	1937	1938	1939
1940	1941	1942	1943
1944	1945	1946	1947
1948	1949	1950	1951
1952	1953	1954	1955
1956	1957	1958	1959
1960	1961	1962	1963
1964	1965	1966	1967
1968	1969	1970	1971
1972	1973	1974	1975
1976	1977	1978	1979
1980	1981	1982	1983
1984	1985	1986	1987
1988	1989	1990	1991
1992	1993	1994	1995
1996	1997	1998	1999
2000	2001	2002	2003
2004	2005	2006	2007
2008	2009	2010	2011
2012	2013	2014	2015
2016	2017	2018	2019
2020	2021	2022	2023
2024	2025	2026	2027
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2032	2033	2034	2035
2036	2037	2038	2039
2040	2041	2042	2043
2044	2045	2046	2047
2048	2049	2050	2051
2052	2053	2054	2055
2056	2057	2058	2059
2060	2061	2062	2063
2064	2065	2066	2067
2068	2069	2070	2071
2072	2073	2074	2075
2076	2077	2078	2079
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2100	2101	2102	2103
2104	2105	2106	2107
2108	2109	2110	2111
2112	2113	2114	2115
2116	2117	2118	2119
2120	2121	2122	2123
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2152	2153	2154	2155
2156	2157	2158	2159
2160	2161	2162	2163
2164	2165	2166	2167
2168	2169	2170	2171
2172	2173	2174	2175
2176	2177	2178	2179
2180	2181	2182	2183
2184	2185	2186	2187
2188	2189	2190	2191
2192	2193	2194	2195
2196	2197	2198	2199
2200	2201	2202	2203
2204	2205	2206	2207
2208	2209	2210	2211
2212	2213	2214	2215
2216	2217	2218	2219
2220	2221	2222	2223
2224	2225	2226	2227
2228	2229	2230	2231
2232	2233	2234	2235
2236	2237	2238	2239
2240	2241	2242	2243
2244	2245	2246	2247
2248	2249	2250	2251
2252	2253	2254	2255
2256	2257	2258	2259
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2988	2989	2990	2991
2992	2993	2994	2995
2996	2997	2998	2999
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3044	3045	3046	3047
3048	3049	3050	3051
3052	3053	3054	3055
3056	3057	3058	3059
3060	3061	3062	3063
3064	3065	3066	3067
3068	3069	3070	

Table IV Present status of models of the human anatomy and degree to which they are used in the biology classrooms.

	On Hand	Used Often	Used Seldom	Never Used
Human skeleton.....	40.0	56.7	43.3	0
Heart.....	18.2	57.7	42.3	0
Eye.....	45.5	60.0	40.0	0
Ear.....	31.5	54.3	45.7	0
Head.....	27.2	51.3	48.7	0
Torso and Head.....	25.2	70.4	29.6	0
Brain.....	9.8	50.0	48.5	1.5
Hand.....	7.7	45.5	51.8	2.7
Foot.....	3.5	40.0	40.0	20.0
Lung.....	3.5	20.0	60.0	20.0
Average.....	21.2	50.6	45.0	4.4

Findings Table IV

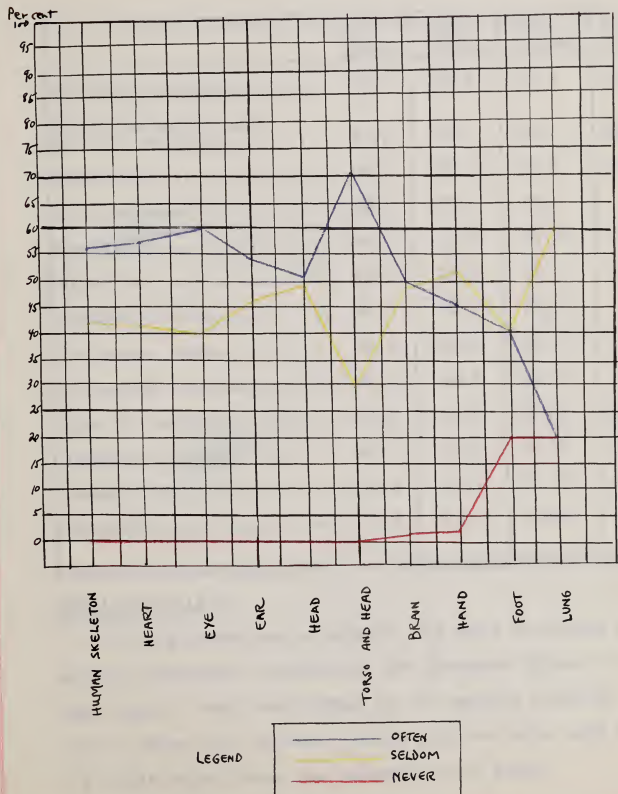
Among the models of the human anatomy, the most available aid is the eye but the torso and head is used more often than the others. Figure 2 gives a graphical representation of the degree to which models of the human anatomy are used in the biology classrooms. This figure makes comparisons relatively simple to illustrate and emphasize.

STATE OF NEW YORK
 SENATE
 REPORT OF THE
 COMMISSIONERS OF THE LAND OFFICE
 FOR THE YEAR 1887

Year	Acres	Value	Remarks
1880	1,000	\$100	Land purchased for the State
1881	1,000	\$100	Land purchased for the State
1882	1,000	\$100	Land purchased for the State
1883	1,000	\$100	Land purchased for the State
1884	1,000	\$100	Land purchased for the State
1885	1,000	\$100	Land purchased for the State
1886	1,000	\$100	Land purchased for the State
1887	1,000	\$100	Land purchased for the State
1888	1,000	\$100	Land purchased for the State
1889	1,000	\$100	Land purchased for the State
1890	1,000	\$100	Land purchased for the State

The following is a list of the lands purchased for the State during the year 1887, with the amount paid therefor, and the name of the person to whom the same were sold. The lands were purchased for the State by the Commissioners of the Land Office, and the same were sold to the persons named in the following list. The amount paid for the same is shown in the second column, and the name of the person to whom the same were sold is shown in the third column.

FIG. 2 DEGREE TO WHICH MODELS OF THE HUMAN ANATOMY
ARE USED IN THE BIOLOGY CLASSROOMS.



THE UNIVERSITY OF CHICAGO LIBRARY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080	1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1092	1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104	1105	1106	1107	1108	1109	1110	1111	1112	1113	1114	1115	1116	1117	1118	1119	1120	1121	1122	1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140	1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157	1158	1159	1160	1161	1162	1163	1164	1165	1166	1167	1168	1169	1170	1171	1172	1173	1174	1175	1176	1177	1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188	1189	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199	1200	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	1217	1218	1219	1220	1221	12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E. Laboratory Equipment

Table V Present status of laboratory equipment and degree to which it is used in the biology classrooms.

	On Hand	Used Often	Used Seldom	Never Used
Laboratory manual.....	30.1	60.5	18.1	20.9
Plastic material and wood for modeling.....	30.8	22.7	31.8	45.5
Aquarium.....	60.1	55.8	40.7	3.5
Microscopes.....	88.1	70.6	29.4	0
Magnifier.....	86.0	61.0	34.9	4.1
Terrarium.....	53.1	55.3	35.5	9.2
Prepared slides.....	83.2	67.2	32.8	0
Microscope lamps.....	32.2	36.9	56.6	6.5
Collecting equipment.....	31.5	48.9	44.4	6.7
Cages for animals.....	30.8	40.9	38.6	20.5
Dissecting equipment.....	67.1	59.4	30.2	10.4
Conservatory.....	22.4	27.5	27.5	45.0
Herbarium.....	30.8	29.5	52.3	18.2

Findings Table V

Of the laboratory equipment, the most available aids are the microscope, magnifier, and prepared slides in that order. Over four-fifths of the schools reported having these aids on hand. These aids are also used to a greater extent than the others of this group.

The following table shows the results of the experiments conducted on the 10th of May 1900. The results are given in the following table.

Time	Temp.	Wind	Direction	Remarks
1.00	61.5	1.00	1.00	.....
1.10	61.5	1.00	1.00	.....
1.20	61.5	1.00	1.00	.....
1.30	61.5	1.00	1.00	.....
1.40	61.5	1.00	1.00	.....
1.50	61.5	1.00	1.00	.....
2.00	61.5	1.00	1.00	.....
2.10	61.5	1.00	1.00	.....
2.20	61.5	1.00	1.00	.....
2.30	61.5	1.00	1.00	.....
2.40	61.5	1.00	1.00	.....
2.50	61.5	1.00	1.00	.....
3.00	61.5	1.00	1.00	.....
3.10	61.5	1.00	1.00	.....
3.20	61.5	1.00	1.00	.....
3.30	61.5	1.00	1.00	.....
3.40	61.5	1.00	1.00	.....
3.50	61.5	1.00	1.00	.....
4.00	61.5	1.00	1.00	.....
4.10	61.5	1.00	1.00	.....
4.20	61.5	1.00	1.00	.....
4.30	61.5	1.00	1.00	.....
4.40	61.5	1.00	1.00	.....
4.50	61.5	1.00	1.00	.....
5.00	61.5	1.00	1.00	.....
5.10	61.5	1.00	1.00	.....
5.20	61.5	1.00	1.00	.....
5.30	61.5	1.00	1.00	.....
5.40	61.5	1.00	1.00	.....
5.50	61.5	1.00	1.00	.....
6.00	61.5	1.00	1.00	.....
6.10	61.5	1.00	1.00	.....
6.20	61.5	1.00	1.00	.....
6.30	61.5	1.00	1.00	.....
6.40	61.5	1.00	1.00	.....
6.50	61.5	1.00	1.00	.....
7.00	61.5	1.00	1.00	.....
7.10	61.5	1.00	1.00	.....
7.20	61.5	1.00	1.00	.....
7.30	61.5	1.00	1.00	.....
7.40	61.5	1.00	1.00	.....
7.50	61.5	1.00	1.00	.....
8.00	61.5	1.00	1.00	.....
8.10	61.5	1.00	1.00	.....
8.20	61.5	1.00	1.00	.....
8.30	61.5	1.00	1.00	.....
8.40	61.5	1.00	1.00	.....
8.50	61.5	1.00	1.00	.....
9.00	61.5	1.00	1.00	.....
9.10	61.5	1.00	1.00	.....
9.20	61.5	1.00	1.00	.....
9.30	61.5	1.00	1.00	.....
9.40	61.5	1.00	1.00	.....
9.50	61.5	1.00	1.00	.....
10.00	61.5	1.00	1.00	.....
10.10	61.5	1.00	1.00	.....
10.20	61.5	1.00	1.00	.....
10.30	61.5	1.00	1.00	.....
10.40	61.5	1.00	1.00	.....
10.50	61.5	1.00	1.00	.....
11.00	61.5	1.00	1.00	.....
11.10	61.5	1.00	1.00	.....
11.20	61.5	1.00	1.00	.....
11.30	61.5	1.00	1.00	.....
11.40	61.5	1.00	1.00	.....
11.50	61.5	1.00	1.00	.....
12.00	61.5	1.00	1.00	.....
12.10	61.5	1.00	1.00	.....
12.20	61.5	1.00	1.00	.....
12.30	61.5	1.00	1.00	.....
12.40	61.5	1.00	1.00	.....
12.50	61.5	1.00	1.00	.....

The following table shows the results of the experiments conducted on the 10th of May 1900. The results are given in the following table.

Table VI Present status of mounted specimens and degree to which they are used in the biology classrooms.

	On Hand	Used Often	Used Seldom	Used Never
Insect collection.....	49.6	50.0	40.3	9.7
Bird collection.....	20.3	62.1	17.2	20.7
Tree grafts.....	19.6	46.4	42.9	10.7
Dry and wet mounts of invertebrates.....	55.2	75.9	24.1	0
Fossils.....	4.2	50.0	50.0	0
Fungi collection.....	2.1	33.3	33.3	33.3
Skulls of various animals.....	4.9	42.9	42.9	14.3
Average.....	22.3	51.5	35.8	12.7

Findings Table VI

Dry and wet mounts of invertebrates are the most often used of the mounted specimens. Next in order are bird and insect collections. A graphic representation of the degree to which mounted specimens are used may be seen on Figure 3.

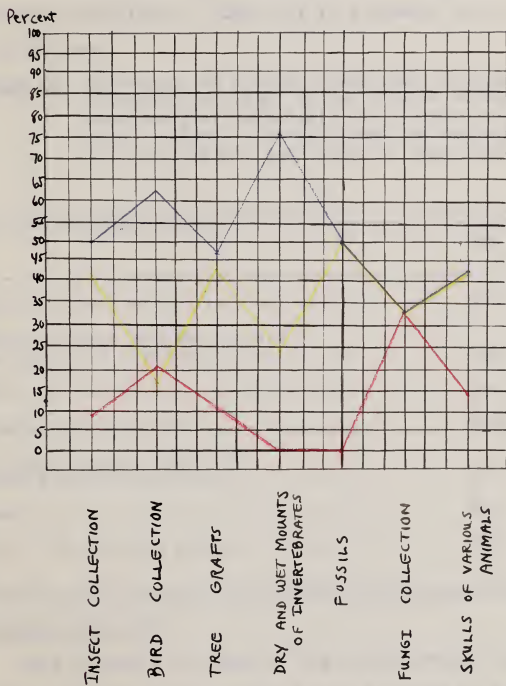
Exhibit the following showing the results of the
 examination conducted on the 22nd day of June 1902

Item	Quesada	Quesada	Quesada	Quesada
1	Quesada	Quesada	Quesada	Quesada
2	Quesada	Quesada	Quesada	Quesada
3	Quesada	Quesada	Quesada	Quesada
4	Quesada	Quesada	Quesada	Quesada
5	Quesada	Quesada	Quesada	Quesada
6	Quesada	Quesada	Quesada	Quesada
7	Quesada	Quesada	Quesada	Quesada
8	Quesada	Quesada	Quesada	Quesada
9	Quesada	Quesada	Quesada	Quesada
10	Quesada	Quesada	Quesada	Quesada

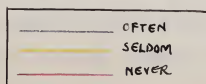
Witness my hand and seal at the City of New York

Notary Public for the State of New York
 My commission expires the 22nd day of June 1902
 Attest my hand and seal at the City of New York
 the 22nd day of June 1902

FIG. 3 DEGREE TO WHICH MOUNTED SPECIMENS ARE
USED IN THE BIOLOGY CLASSROOMS.



LEGEND



THE UNIVERSITY OF CHICAGO PRESS

CHICAGO, ILLINOIS 60607



Time (min)	Temperature (°C)
0	0
10	40
20	80
30	85
40	88
50	89
60	90
70	90
80	90
90	90
100	90

Figure 1. Temperature vs. Time.

F. Classroom Facilities

Heads of the biology departments were asked to report on how well equipped their classrooms were with respect to classroom facilities. Table VII is a summary of the findings in this area.

Table VII Percentage of biology classrooms equipped with electrical outlets, motion picture screens (either stationary or portable), gas, general storage room, suitable flat-top desks for student laboratory use, water, and space for laboratory use.

	Yes	No
Electrical outlets.....	86.0	14.0
Motion picture screens, either stationary or portable.....	72.0	18.0
Gas.....	74.8	25.2
General storage room.....	60.8	39.2
Suitable flat-top desks for student laboratory use.....	51.1	48.9
Water.....	83.2	16.8
Space for laboratory use.....	70.6	29.4

Findings Table VII

The biology classrooms of the public senior high schools of Massachusetts are reasonably well equipped with facilities for using audio-visual aids. Almost four-fifths of the schools have gas, motion picture screens (either stationary

ANNEX 1

1. The purpose of this annex is to provide a summary of the information contained in the main text of the report, and to provide a brief overview of the findings of the study.

2. The findings of the study are presented in the following table, which shows the results of the various tests conducted, and the conclusions drawn from them.

Test	Result	Conclusion
1.1	1.1.1	1.1.1.1
1.2	1.2.1	1.2.1.1
1.3	1.3.1	1.3.1.1
1.4	1.4.1	1.4.1.1
1.5	1.5.1	1.5.1.1
1.6	1.6.1	1.6.1.1
1.7	1.7.1	1.7.1.1
1.8	1.8.1	1.8.1.1
1.9	1.9.1	1.9.1.1

3. The results of the study are presented in the following table, which shows the results of the various tests conducted, and the conclusions drawn from them.

or portable) and space for laboratory use. Over four-fifths of the schools reported as having electrical outlets and water. However, as many as 14.0 per cent and 16.8 per cent reported electrical outlets and water respectively as not available. This situation is not only deplorable in itself, but is a drawback to the use of other aids.

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G. Projection Equipment

In the investigation of projection equipment, information was requested under five different headings: C, B, S, N, and L. The meaning of the symbols follow Table VIII which reports on the status of projection equipment. In subsequent tables the meaning of these symbols will remain the same unless otherwise stated.

Table VIII Present status of projection equipment.

	C	B	S	N	L
Micro-projector.....	30.8	8.4	.7	60.1	18.2
Stereoscope.....	8.4	9.1	0	82.5	10.5
Lantern slide projector.....	30.8	23.1	6.3	39.8	11.2
Stereopticon.....	16.8	6.3	2.1	74.8	6.3
Opaque projector.....	6.3	13.9	0	89.8	8.4
Sound film projector.	35.7	36.4	3.5	24.4	11.9

C: Available in Classroom at all times.

B: Available somewhere in the same Building.

S: Available somewhere in the same School System.

N: Not available.

L: Should Like to have available.

Findings Table VIII

The majority of schools are well equipped with sound film projectors with 72.1 per cent or 103 schools out of 143 schools reporting this aid either in the biology classroom or in the same building. Table VIII shows that 39.9 per cent of the schools contacted have micro-projectors and 60.2 per cent have lantern slide projectors available to them. More than half of the schools do not have the stereopticon, stereoscope, and opaque projector available. These are also the least desired of the projection equipment. The micro-projector is the aid of this group which most schools would like available. On the whole, it appears that many schools are in need of more projection equipment.

Lantern Slides

Table IX Present status of different types of lantern slides.

Type of Slide	C	B	S	N	L
Plain glass.....	25.2	18.9	2.1	53.8	6.3
Ground glass.....	16.1	6.3	2.1	75.5	2.1
Cellophane.....	5.6	2.1	0	92.3	4.2
Silhouette.....	2.1	2.8	0	95.1	2.1
Photographic.....	6.3	3.5	2.1	88.1	2.1
Kodachrome.....	10.5	11.2	2.8	75.5	10.5

Findings Table IX

The plain glass type of lantern slide is more available than any other type. The kodachrome type of lantern slide is the most desired. The results of the table show that few schools have lantern slides and that few schools desire this type of aid in their biology department.

Table X Present status of sound films listed in the questionnaire.

Title	C	B	S	N	L
How We See.....	0	0	0	100	6.3
Tiny Water Animals.....	0	0	.7	99.3	3.5
The Nervous System.....	0	0	0	100	9.1
Respiration.....	0	0	0	100	4.2
Heart and Circulation...	1.4	.7	.7	97.2	10.5
Conservation.....	0	0	0	100	2.8
Heredity.....	0	0	0	100	2.1
A. B. C. D. of Health...	0	.7	0	99.3	3.5
Plant Growth.....	0	0	0	100	2.1
In the Beginning.....	0	0	0	100	2.8
Flowers at Work.....	.7	0	0	99.3	2.8
This is T. B.	0	0	0	100	2.1
Six-Legged Saboteurs....	0	0	0	100	3.5
Birds of North America..	.7	0	0	99.3	4.2
Marine Life.....	.7	0	0	99.3	3.5
First Aid.....	0	.7	.7	98.6	1.4
Body Defenses Against Disease.....	.7	0	.7	98.6	2.8
Reproduction Among Mammals.....	.7	0	.7	98.6	6.3

Table 1. The first 1000 numbers of the sequence $\{a_n\}$ for $n = 1, 2, \dots, 1000$.

n	a_n	n	a_n	n	a_n
1	1	333	333	667	667
2	2	334	334	668	668
3	3	335	335	669	669
4	4	336	336	670	670
5	5	337	337	671	671
6	6	338	338	672	672
7	7	339	339	673	673
8	8	340	340	674	674
9	9	341	341	675	675
10	10	342	342	676	676
11	11	343	343	677	677
12	12	344	344	678	678
13	13	345	345	679	679
14	14	346	346	680	680
15	15	347	347	681	681
16	16	348	348	682	682
17	17	349	349	683	683
18	18	350	350	684	684
19	19	351	351	685	685
20	20	352	352	686	686
21	21	353	353	687	687
22	22	354	354	688	688
23	23	355	355	689	689
24	24	356	356	690	690
25	25	357	357	691	691
26	26	358	358	692	692
27	27	359	359	693	693
28	28	360	360	694	694
29	29	361	361	695	695
30	30	362	362	696	696
31	31	363	363	697	697
32	32	364	364	698	698
33	33	365	365	699	699
34	34	366	366	700	700
35	35	367	367	701	701
36	36	368	368	702	702
37	37	369	369	703	703
38	38	370	370	704	704
39	39	371	371	705	705
40	40	372	372	706	706
41	41	373	373	707	707
42	42	374	374	708	708
43	43	375	375	709	709
44	44	376	376	710	710
45	45	377	377	711	711
46	46	378	378	712	712
47	47	379	379	713	713
48	48	380	380	714	714
49	49	381	381	715	715
50	50	382	382	716	716
51	51	383	383	717	717
52	52	384	384	718	718
53	53	385	385	719	719
54	54	386	386	720	720
55	55	387	387	721	721
56	56	388	388	722	722
57	57	389	389	723	723
58	58	390	390	724	724
59	59	391	391	725	725
60	60	392	392	726	726
61	61	393	393	727	727
62	62	394	394	728	728
63	63	395	395	729	729
64	64	396	396	730	730
65	65	397	397	731	731
66	66	398	398	732	732
67	67	399	399	733	733
68	68	400	400	734	734
69	69	401	401	735	735
70	70	402	402	736	736
71	71	403	403	737	737
72	72	404	404	738	738
73	73	405	405	739	739
74	74	406	406	740	740
75	75	407	407	741	741
76	76	408	408	742	742
77	77	409	409	743	743
78	78	410	410	744	744
79	79	411	411	745	745
80	80	412	412	746	746
81	81	413	413	747	747
82	82	414	414	748	748
83	83	415	415	749	749
84	84	416	416	750	750
85	85	417	417	751	751
86	86	418	418	752	752
87	87	419	419	753	753
88	88	420	420	754	754
89	89	421	421	755	755
90	90	422	422	756	756
91	91	423	423	757	757
92	92	424	424	758	758
93	93	425	425	759	759
94	94	426	426	760	760
95	95	427	427	761	761
96	96	428	428	762	762
97	97	429	429	763	763
98	98	430	430	764	764
99	99	431	431	765	765
100	100	432	432	766	766

Findings Table X

The sound films in this table were inserted in the check list by the heads of the biology departments as those used.

Table X reveals the following conclusions:

1. Only 7 schools out of 143 or 4.9 per cent have biology sound films available in the classroom at all times.
2. Only 3 schools out of 143 or 2.1 per cent have biology sound films available in the same school building.
3. Only 5 schools out of 143 or 3.5 per cent have biology sound films available in the same school system.
4. In approximately 128 schools, biology sound films are not available.

A summary of these conclusions is that few sound biology films are available in the classrooms, in the same building, and in the same school system of the public senior high schools of Massachusetts.

Table XI Present status of silent films listed in the questionnaire.

	C	B	S	N	L
How We Hear.....	0	0	0	100	0
Plant Life.....	0	0	0	100	1.4
Mosquitoes.....	0	.7	0	99.3	2.8
Energy from Sunlight.....	0	0	0	100	1.4
Bacteria.....	0	.7	.7	98.6	3.5
The Living Cell.....	0	.7	0	99.3	3.5
Native American Birds.....	0	0	.7	99.3	.7
Ask Your Dentist.....	0	0	0	100	1.4
The Blood.....	.7	0	.7	98.6	3.5
Microscopic Animals.....	0	.7	0	99.3	4.2
Seashore Animals.....	0	.7	0	99.3	3.5

Findings Table XI

Only 9 schools or 6.3 per cent have silent biology films available in the biology classrooms, in the same school building, and in the same school system of the 143 schools taking part in this tabulation.

Approximately 37 schools out of 143 desire to have this aid available. In short, very few schools have silent biology films available to them.

Table XII Present status of film strips listed in questionnaire.

Title of Film Strip	C	B	S	N	L
Louis Pasteur.....	.7	0	0	99.3	1.4
Florence Nightingale.....	.7	0	0	99.3	.7
Edward L. Trudeau.....	.7	0	0	99.3	.7
Edward Jenner.....	.7	0	0	100	1.4
Walter Reed.....	.7	0	0	99.3	2.1
Hero Health Series.....	0	.7	0	99.3	2.8
Burns, Wounds, and Fractures.....	0	0	.7	99.3	2.1
Wild Flowers.....	0	.7	0	99.3	2.1
Trichinosis.....	0	.7	.7	98.6	1.4
Grasshoppers.....	0	0	0	100	.7
Grafting and Budding.....	0	0	0	100	.7
Life Functions of the Frog..	0	0	.7	99.3	2.8

Findings Table XII

Only 10 schools out of 143 or 7 per cent have biology film strips available to them. Approximately 27 schools desire to have this type of aid available to them.

Table XIII Present status of stereographs.

	C	B	S	N	L
Stereographs	4.2	2.1	2.8	90.9	4.2

Findings Table XIII

Table XIII reveals the fact that very few schools have stereographs available in the classroom, in the same school building, and in the same school system. Only a small per cent of the schools desire to have this aid available to them.

H. ActivitiesTable XIV Percentage of schools making use of different activities.

	N	E	S	R	X
Biology clubs.....	50.4	18.2	2.8	.7	27.9
Planning and working on exhibits.....	30.8	35.1	21.2	7.7	5.2
Field work and trips.....	25.2	27.2	25.2	7.7	14.7
Dramatizations.....	68.5	13.9	1.4	1.4	14.8
Scrapbook.....	36.4	34.3	11.2	3.5	14.6

- N. No time for it at all.
 E. Encouraged, but not required.
 S. Sometimes required.
 R. Regularly required.
 X. Extra-curricular only.

Findings Table XIV

Among those listed, field work, whether on an extra-curricular basis or on a regularly required basis, is the most common activity engaged in by the biology classrooms. Approximately 25 per cent of the schools reported having no time for it at all.

Very few schools require activities, as a group, on the regularly required basis. Dramatizations were the least engaged in of the activities with about 98 schools out of 143 reporting having no time for them at all.

1. Comments

On the questionnaire sent to the heads of the biology departments there was a section for comments. The writer hesitated to report these because he felt that they might be opinionated and subjective. However, value will be found in the study of the comments. He found them to be brief, sensible, and thought provoking.

Some of the biology department heads went overboard on their enthusiastic acceptance of audio-visual aids for the biology classroom. Others gave modified approval, accepting the tried and tested but avoiding anything radical. Finally, there was a group that virtually denied that use of audio-visual aids beyond writing on the black-board was any good at all.

The most valuable thing about the reaction of the biology department heads was this: many teachers often operate under conditions imposed externally, beyond their better judgment and their control. On the questionnaire the biology department heads had a chance to express themselves concerning the situation under which they as teachers have to operate. Thus, we can examine the status of audio-visual aids in the classroom from the teacher's point of view.

The remarks were informal. However, as is frequently the case, a casual remark will get right at an actual

condition.

First we should like to discuss the negative votes. These comments were brief and to the point. Most of them were not dissimilar in wording or in content. The universal theme was no time on the part of the teacher and no money on the part of the school system. This was reiterated time and again. It was the most common reaction. One or two were almost shocking because of their apathy.

"Lack of time to obtain and set up projector for various periods in different rooms."

This comment seems to indicate something wrong in the biology teaching program of this school. There is inadequacy in the planning when the biology teacher is so unencumbered by teaching tools that classroom teaching periods are held for the conveniences of time and space. The writer feels that a teacher may have a fine group of audio-visual aids and still go from room to room with them. However, it is best to be established first, if possible, in a room where permanent aids may be set up.

The comment quoted also shows a common error about audio-visual aids. To many teachers a projector, motion or still, and nothing else means audio-visual aids. If they are denied this they become dispirited and lose interest in other aids which to them seem unimportant.

The following remarks demonstrate the apathy of some teachers towards using audio-visual aids:

"One teacher -- 162 pupils -- no free periods per week -- given little time."

"These are time consuming affairs. Most teachers have many jobs to do."

"Biology one period (45 minutes) every day in week. Other classes do not permit intensive work."

We cannot ignore these reactions but we can be skeptical of the skepticism and impatient with the "do-nothing" attitude expressed. A little effort and improvisation may yield audio-visual aids as good as the finest sound projector run by a professional operator showing the latest in science films.

"No funds to purchase these aids because ours is a small school."

There is never enough money to buy all school equipment. A study of the facts shows the availability of many charts, catalogues, illustrations, and even films free of charge from governmental agencies and from industrial films. Certainly there are endless ways of improvising and using ingenuity if the spirit were eager and willing and not tired.

Since most biological functions are those of motion, the use of movies in the classroom is important. The fact that they are beyond the funds of some school systems should not discourage their use. It is easy to say no time, no funds, but it is not serving progress to stop here. To advance, inertia need be overcome.

One teacher made a valuable contribution with this comment, "Field trips, I think, are as valuable as any other aid. Wish we had time for more of them."

The quantity of audio-visual aids are not so much to be emphasized as the pointedness, the aptness, and the sharpness they have to arouse interest. A student may remember, in later years, nothing of his biology studies save one field trip he took and the vivid impressions made thereon which remained with him forever. Funds are not needed for field trips. The time can be found or made. The only difficult proposition is the ingenuity, the planning, the eagerness of the teacher and his willingness to do more than the minimum.

And there was the inevitable debunking of audio-visual aids as "the softening up process that is making teaching like pre-masticated food for infants. Entertainment." Another teacher, "Interest is aroused but question the carry-over of the teacher performing the demonstration to absorption by the pupil."

We feel that if the audio-visual aid entertains to the point of awakening the interest of the pupil, this is the strongest recommendation for audio-visual aids. For what teacher does not count among his assets the ability to get the undivided interest of his class. The educative process can best function with the active cooperation of the learner and this is at its best when the pupil is aroused.

"An audio-visual aid is meaningless without the human

element of the teacher." This teacher need not fear replacement by a projector, let us say, which takes on the functions of the teacher. Unrestrained use of aids will result in mortification of the teaching process and, we think, of the learning process. The teacher must use the aid as a tool and not as a crutch. Inspiration, personality, verbal facility, good judgment, indeed, the whole human side of teaching cannot be traded for audio-visual aids and comments like the one just quoted seems to the writer superfluous, save as a warning to the teacher that use of the aids must never mean backsliding from vigorous teaching methods. Moreover, we feel that the use of aids will not usually indicate the lax teacher; more than often it is the industrious, eager, and proficient man who is keeping up with his field who knows and uses the different aids and who often has to overcome hostility to install them.

"Some information on how to use aids as well as an evaluation of the aids particularly in the film field would be most valuable."

It was comments like this that gave the writer encouragement in writing this thesis and made him feel that in a small way his work would be a contribution for those who were honestly not aware of what was being done in audio-visual aids for senior high school biology classes. Most working teachers have little of the time necessary for the developed research to find the available material.

Educational publishers or school boards might supply the biology teacher with brochures outlining what aids he could use. These would list those commercially available and suggest also many that could be improvised, obtained free, or had with little effort by the teacher. The aids, extremely useful at times in the biology classroom, are sometimes the most expensive, unfortunately. This is particularly true of films, sound and silent, movies, and slides. But even so, excellent sound projectors may be had for about \$500.00 and many science films for the biology class are obtainable free on a loan basis from industrial concerns, particularly food processors, and governmental agencies.

A pamphlet, like the one suggested above, might indicate the source of supply, the minimum cost of the audio-visual aid and particularly how movies can be brought into the classroom. But beyond this, the biology teacher must have immediately at hand information that will enable him to determine what aids there are, where they can be had, their functions, and their cost. However, he should decide what aid to use for his particular teaching situation. He should be left to himself when it comes to fitting the proper aid into his own teaching setup.

"This sounds interesting and I will be interested in the results (of this paper). Our greatest difficulty is lack of storage space and improper means for darkening the room."

Most of our school buildings are not new, and their original design and construction never made allowance for some of the prerequisites of modern audio-visual aids. Some schoolrooms have improper wiring and no facilities for sound motion films, for example. Ideally we should like to have one room set aside for biology and there we could have dark curtains, a projector, slide films and whatever equipment necessary for the audio-visual aids decided upon by that biology department. The writer has been present at slide demonstrations at which students had to be posted at the window curtains to hold them back lest they belly out and let light in, and he has been at another at which the teacher pressed a button to draw light proof shades that blackened the room.

We are employing modern design in our newer homes and factories. It is equally pertinent and important that we devote this planning to our educational institutions and make allowances for the possible use of audio-visual aids in the classrooms.

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CHAPTER IV

SUMMARY AND SUGGESTIONS FOR FURTHER STUDY

A. Present Status of Audio-Visual AidsBlackboard Equipment

The biology classrooms of the public senior high schools of Massachusetts are well equipped and make extensive use of blackboards and chalk. Almost 98 per cent use blackboards and almost 64 per cent use colored chalk often. None of the schools taking part in the survey never use blackboards and only 1.7 per cent never use colored chalk.

Still Pictorial Materials

This study shows that still pictorial materials are on hand to a large degree in the biology classrooms. Of this group, wall charts are the most used with 90 per cent of the schools reporting making frequent use of them. Diagrams and posters, and bulletin boards came next as being used often. The percentage of schools that never use this type of aid ranges from only 0 per cent to 16.1 per cent.

Biology Classroom Equipment

With the exception of models of the human anatomy over 50 per cent of the biology classrooms of the schools taking part in the survey are equipped with classroom equipment. The percentages of schools which never use this type of aid in connection with the teaching of biology range from 0 per cent for bookcases (with biology books for use other

than regular text) to 6.6 per cent for filing cabinets.

Laboratory Equipment

Among the laboratory equipment, the microscope, magnifier, prepared slides, dissecting equipment, and aquarium are the most available aids in that order. Over half of the schools reported having these aids on hand. These aids are also used to a greater extent than the others of this group, namely, laboratory manual, plastic material and wood for modeling, microscope lamps, collecting equipment, cages for animals, mounted specimens, conservatory, and herbarium.

Mounted Specimens

Mounted specimens are not available to a large extent in the biology classrooms. Only a few schools reported fossils, fungi, and skulls of various animals on hand. However, where mounted specimens are available, frequent use is made of them.

Classroom Facilities

Over 50 per cent of the schools contacted are reasonably well equipped with electrical outlets, motion picture screens (either stationary or portable), gas, general storage room, suitable flat-top desks for student laboratory use, space for laboratory use, and water. However, 14.0 per cent of the schools reported electrical outlets and 16.8 per cent reported water as not available. This situation is deplorable not only in itself but is a hindrance to the

use of other aids.

Projection Equipment

The status of projection equipment in the biology classrooms could be improved. Although 72.1 per cent reported sound film projectors and 60.2 per cent reported lantern slide projectors available, less than half of the schools have the stereopticon, stereoscope, opaque projector and micro-projector available.

Projected Aids

The present status of projected aids is such that approximately 9 out of 10 schools do not have lantern slides, films, film strips and stereographs. Very few schools desire to have these type of aids available to them. This condition does not speak well for the public senior high schools of Massachusetts.

Activities

Very few schools engage in activities on a required basis. Field work is the most common activity of the biology classrooms. The other activities listed in the questionnaire, namely, biology clubs, planning and working on exhibits, dramatizations and scrapbook are used by a very few schools and on a basis other than "required." On the whole, very little is done in this area by the biology classes of the public senior high schools in Massachusetts.

Conclusion

The biology classrooms of the senior high schools of

Massachusetts are reasonably well equipped with some audio-visual aids. This is especially true in the areas of black-board equipment, still pictorial materials, classroom equipment, laboratory equipment, and classroom facilities. In the areas of mounted specimens, projection equipment, projected aids, and activities very little is available. A summary of teacher comments such as: lack of time, lack of money, lack of information, lack of facilities, and skepticism as to the benefits to be derived indicates the reason for this state of affairs.

B. Suggestions for Further Study

The following are suggestions for further study in the field of audio-visual aids for the teaching of biology.

1. Controlled studies to determine whether any benefits are derived from the use of audio-visual aids as compared with the traditional method of instruction.
2. Studies on the relative effectiveness of different audio-visual aids in the teaching of different biological generalizations.
3. Studies of the factors which determine the extent of an audio-visual aid program in any school system.
4. A study, a number of years hence, to determine any change from this study in the status of these aids and the use that is made of them in the biology classrooms of the senior high schools of Massachusetts.
5. Service papers by educational publishers and school boards in the form of brochures or pamphlets indicating what aids are available in biology, their functions, their cost, and where they may be obtained.

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APPENDIX

**Questionnaire on the Present Status of Aids to Learning being
used in Biology Classrooms**

Please encircle the number at the left of those aids to learning biology which you have, and place an "X" in the proper column at the right to indicate the frequency with which each is used. (where indication of frequency is appropriate.)

Often Seldom Never

- | | | | |
|------------------------------|-------|-------|-------|
| 1. Blackboards..... | _____ | _____ | _____ |
| 2. Colored chalk..... | _____ | _____ | _____ |
| 3. Bulletin boards..... | _____ | _____ | _____ |
| 4. Maps..... | _____ | _____ | _____ |
| 5. Graphs..... | _____ | _____ | _____ |
| 6. Photographs..... | _____ | _____ | _____ |
| 7. Diagrams and Posters..... | _____ | _____ | _____ |
| 8. Cartoons..... | _____ | _____ | _____ |
| 9. Photos of Biologists..... | _____ | _____ | _____ |
| 10. Wall charts..... | _____ | _____ | _____ |

Please list names of charts:

- (A) _____
- (B) _____
- (C) _____
- (D) _____

- | | | | |
|---|-------|-------|-------|
| 11. Filing cabinets..... | _____ | _____ | _____ |
| 12. Exhibit cases or shelves..... | _____ | _____ | _____ |
| 13. Demonstration desk for teacher..... | _____ | _____ | _____ |
| 14. Human models..... | _____ | _____ | _____ |
| (A) Eye..... | _____ | _____ | _____ |
| (B) Ear..... | _____ | _____ | _____ |
| (C) Head..... | _____ | _____ | _____ |
| (D) Torso and Head..... | _____ | _____ | _____ |

Please list others:

- (E) _____
- (F) _____
- (G) _____

- | | | | |
|--|-------|-------|-------|
| 15. Bookcases with biology books
for use other than regular text..... | _____ | _____ | _____ |
| 16. Human skeleton..... | _____ | _____ | _____ |
| 17. Space for laboratory use..... | _____ | _____ | _____ |
| 18. Laboratory manual..... | _____ | _____ | _____ |
| 19. Mounted specimens..... | _____ | _____ | _____ |
| (A) Insect collection..... | _____ | _____ | _____ |
| (B) Bird collection..... | _____ | _____ | _____ |
| (C) Tree grafts..... | _____ | _____ | _____ |
| (D) Dry and wet mounts
of invertebrates..... | _____ | _____ | _____ |

Please list others:

- (E) _____
- (F) _____
- (G) _____

- | | | | |
|--|-------|-------|-------|
| 20. Plastic material and wood
for modeling..... | _____ | _____ | _____ |
| 21. Aquarium..... | _____ | _____ | _____ |
| 22. Microscopes..... | _____ | _____ | _____ |
| 23. Magnifiers..... | _____ | _____ | _____ |

1. The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that every entry must be clearly documented and verified by the relevant parties. This ensures transparency and accountability in the financial process.

2. The second section outlines the procedures for handling discrepancies. It states that any inconsistency found in the records should be immediately reported to the supervisor. A thorough investigation must then be conducted to identify the cause of the error and implement corrective measures to prevent future occurrences.

3. The third part of the document details the requirements for the monthly financial review. It specifies that all data must be compiled and analyzed by the end of each month. The results of the review should be presented in a clear and concise report to the management team, highlighting any trends or areas of concern.

4. The fourth section describes the process for updating the accounting system. It notes that any changes to the system must be approved by the IT department and the finance team. This ensures that the system remains secure and compliant with all relevant regulations.

5. The final part of the document provides a summary of the key points discussed. It reiterates the importance of accuracy, transparency, and regular communication in the financial management process. It also encourages all staff members to take ownership of their roles and contribute to the overall success of the organization.

	Often	Seldom	Never
24. Terraria			
25. Prepared slides.....			
26. Microscope lamps			
27. Collecting equipment..			
28. Cages for animals			
29. Dissecting equipment .			
30. Conservatory			
31. Herbarium (Pressed plants) ...			
Please list others:			

Please place an "X" in the appropriate column in answer to the following questions.

	Yes	No
32. Are the biology classrooms equipped with electrical outlets for projection equipment and other general use?.....		
33. Are the biology classrooms equipped with motion picture screens, either stationary or portable?		
34. Are the biology classrooms equipped with gas? .		
35. Are the biology classrooms equipped with at least one sink?		
36. Are the biology classrooms equipped with a general storage room?		
37. Are the biology classrooms equipped with suitable flat-top desks for student laboratory work?		
38. Are the biology classrooms equipped with water?		

The columns N, E, S, R, and X represent the following, respectively:

- N. No time for it at all.
- E. Encouraged, but not required.
- S. Sometimes required.
- R. Regularly required.
- X. Extra-curricular only.

Please place an "X" in the appropriate column.

	N	E	S	R	X
39. Biology clubs					
40. Planning and working on biological exhibits					
41. Field work and trips					
42. Projects					
43. Dramatizations					
Please list others:					

The columns C, B, S, N, and L represent the following, respectively:

- C. Available in Classroom at all times.
- B. Available somewhere in the same Building
- S. Available somewhere in the same School System.
- N. Not available.
- L. Should Like to have available.

Please place an "X" in the appropriate column or columns.

44. Micro-projector.....				
45. Stereoscope.....				
46. Lantern slide projector.....				
47. Lantern slides.....				
plain glass.....				
ground glass.....				
cellophane.....				
silhouette.....				
photographic.....				
Kodachrome.....				
48. Sound film projector.....				
49. Sound films.....				
Please list those used:				
(A).....				
(B).....				
(C).....				
(D).....				
(E).....				
(F).....				
50. Film strips.....				
Please list those used:				
(A).....				
(B).....				
(C).....				
(D).....				
(E).....				
(F).....				
51. Silent films.....				
Please list those used:				
(A).....				
(B).....				
(C).....				
(D).....				
(E).....				
(F).....				
52. Stereographs.....				
53. Stereopticon.....				
54. Opaque projector (Salopecticon).....				
Please list others:				
.....				
.....				
.....				

Your suggestions, comments, and criticisms regarding this study will be gratefully received. Please use the back of this page for this purpose.



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